

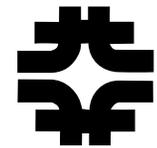
The Fermilab Experimental Program – the short version

Michael Witherell

Users meeting

June 2, 2003

The Fermilab program



The Weak Scale and the Energy Frontier

- The Tevatron program: CDF and D0
- US-LHC and US-CMS
- Linear collider R&D

Neutrino and Lepton Flavor Physics

- The US accelerator-based neutrino program: MiniBooNE and NuMI/MINOS

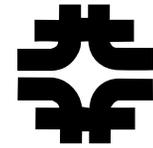
Quark Flavor Physics and CP violation

- Quark flavor physics experiments to operate in 2009: BTeV and CKM

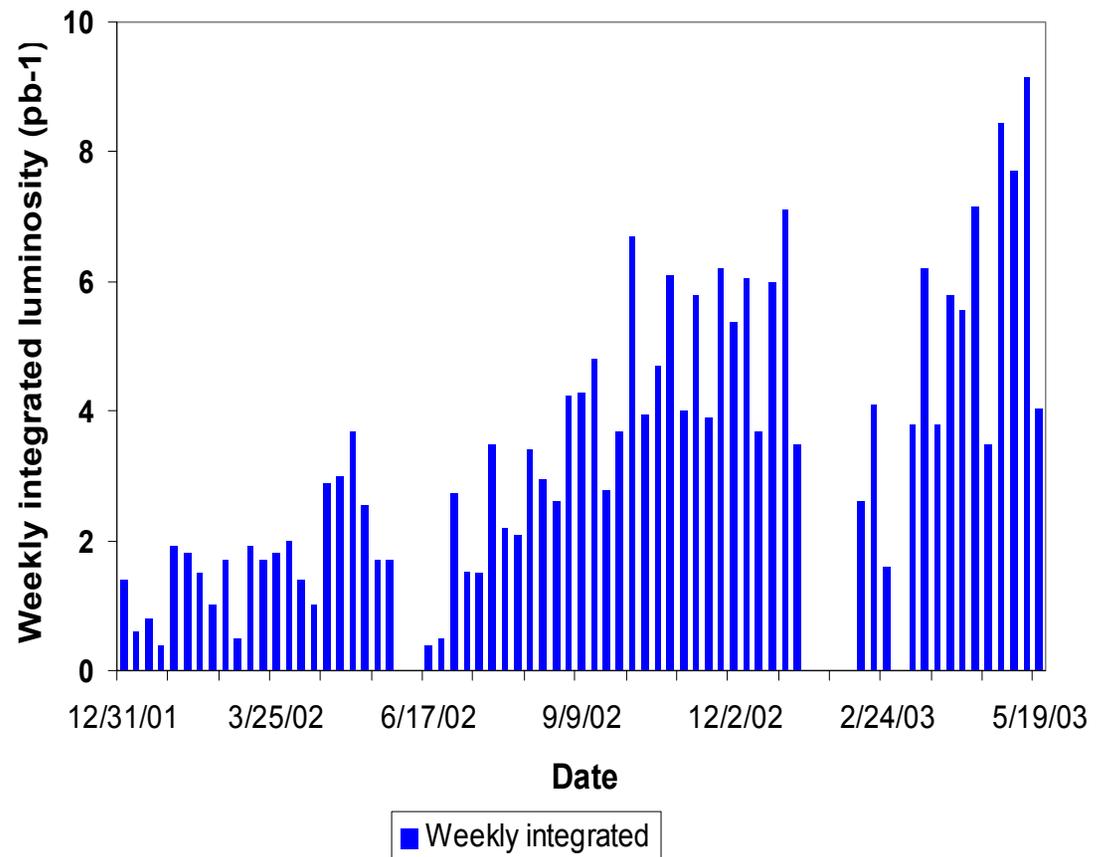
Particle Astrophysics and Cosmology

- Sloan Digital Sky Survey
- The Auger Cosmic Ray Observatory
- The Cryogenic Dark Matter Search

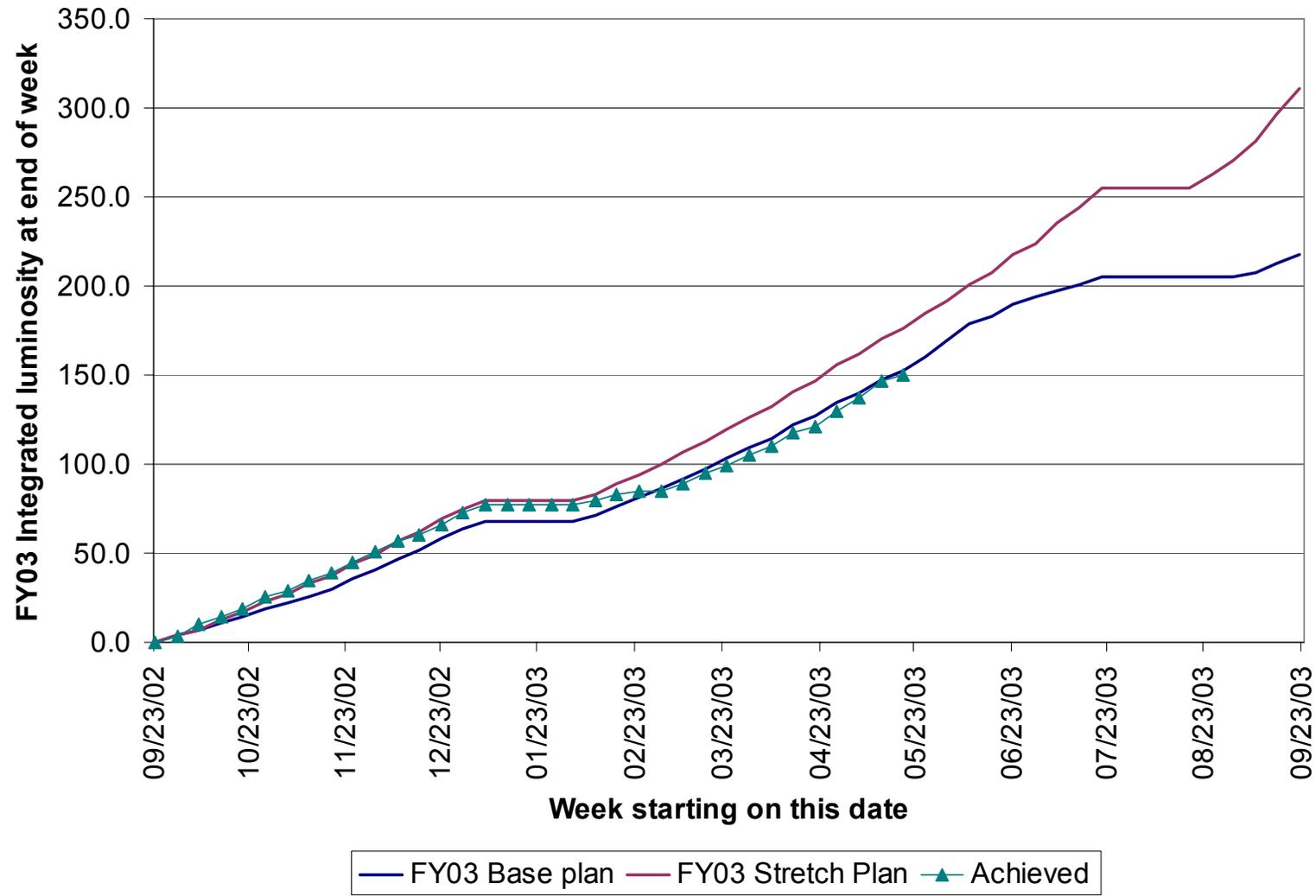
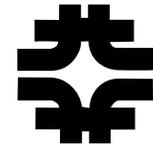
Weekly integrated luminosity



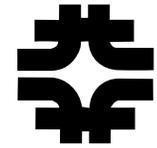
	<u>Now</u>	<u>9/02</u>
Best week(pb ⁻¹)	9.1	4.6
Typical week	7.5	4.0
Best luminosity (10 ³¹ cm ⁻² s ⁻¹)	4.5	3.0



FY 2003 Plan

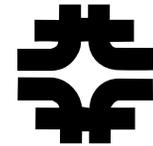


Run II of CDF and D0



- CDF and D0 are the only experiments able to address many of the central physics questions of particle physics.
- First results from Run II cover a broad range of physics topics. You will see these later at this meeting.
- It is especially important for the field of particle physics that we sustain this strong physics program over the next several years.
- We are about to submit the detailed accelerator plan for the next several years.
 - I will come back and talk about this plan after covering the rest of the scientific program.

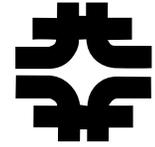
FY04 budget request is bad for HEP, worse for Fermilab.



FY	02	03	04	02-04
HEP	713.2	715.7	738.0	3.5%
Fermilab base	286.2	284.8	288.5	0.8%
Fermilab total	310.6	311.6	303.3	-2.4%

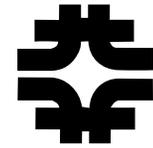
- In 12/02, we said it would take ~\$306 M in FY 04 to sustain the full Run II plan, ongoing projects, and minimal preparation for the future.
- Fermilab budget is \$288.5M.
- This is down 7% relative to inflation since FY2002.
 - General reduction will take it down further.

The Neutrino Program

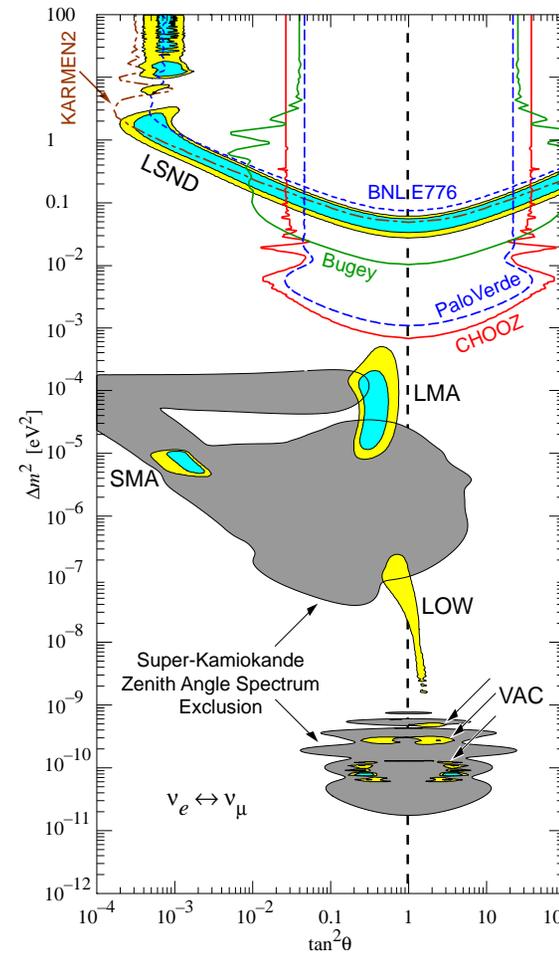
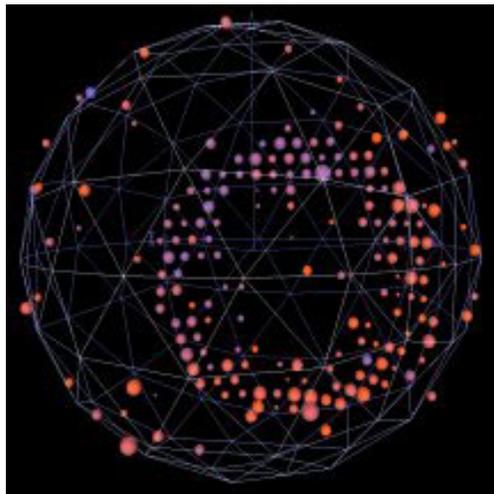


- **Neutrino oscillations** are the greatest experimental surprise of the last decade.
 - large mixing among the three neutrino flavors
 - possibility of observing an important new instance of CP violation
 - possible connection through the see-saw mechanism to a very high mass scale
- Fermilab is home of the US accelerator-based neutrino program:
 - MiniBooNE
 - NuMI/MINOS

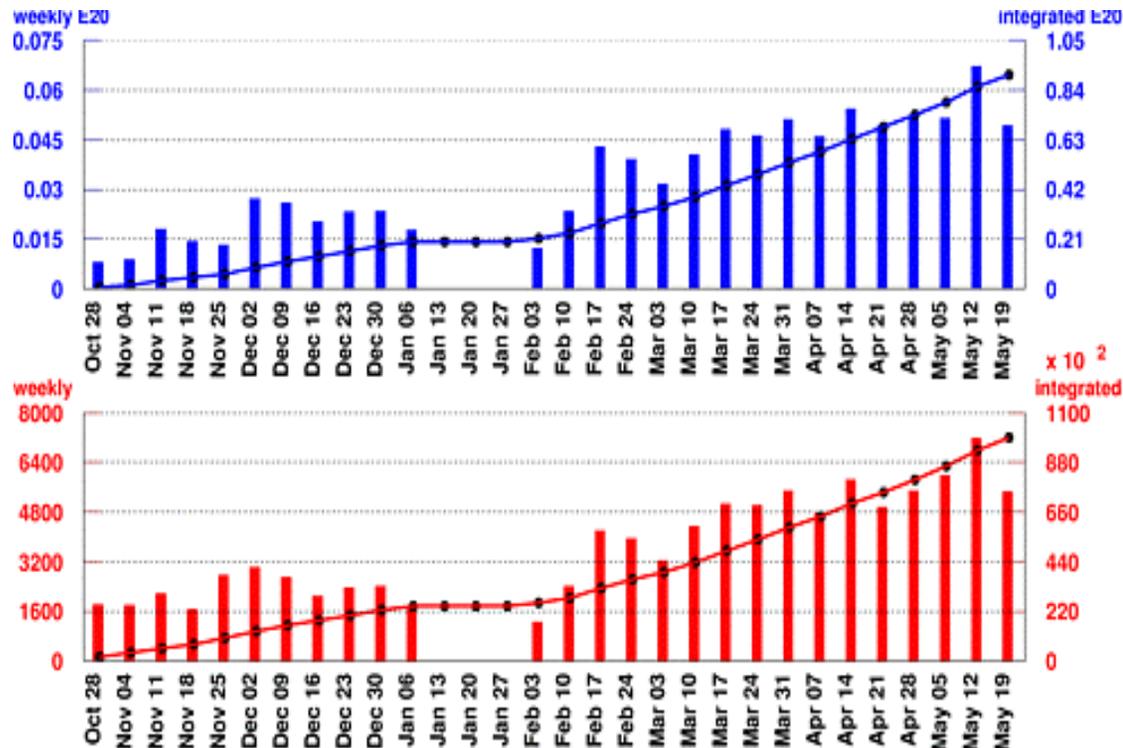
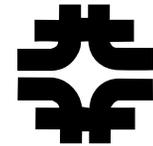
MiniBooNE



- MiniBooNE is designed to follow up on the LSND evidence of a $\bar{\nu}_\mu - \bar{\nu}_e$ oscillation at high Δm^2 , requiring a sterile neutrino
- The experiment is running well in its first year of operation.
- Program to decrease losses in the booster have made it possible to increase the flux.



MiniBooNE Beam Status



Number of Protons on Target

To date: 0.9049 E20

Largest week: 0.0671 E20

Latest week: 0.0493 E20

Number of Neutrino Events

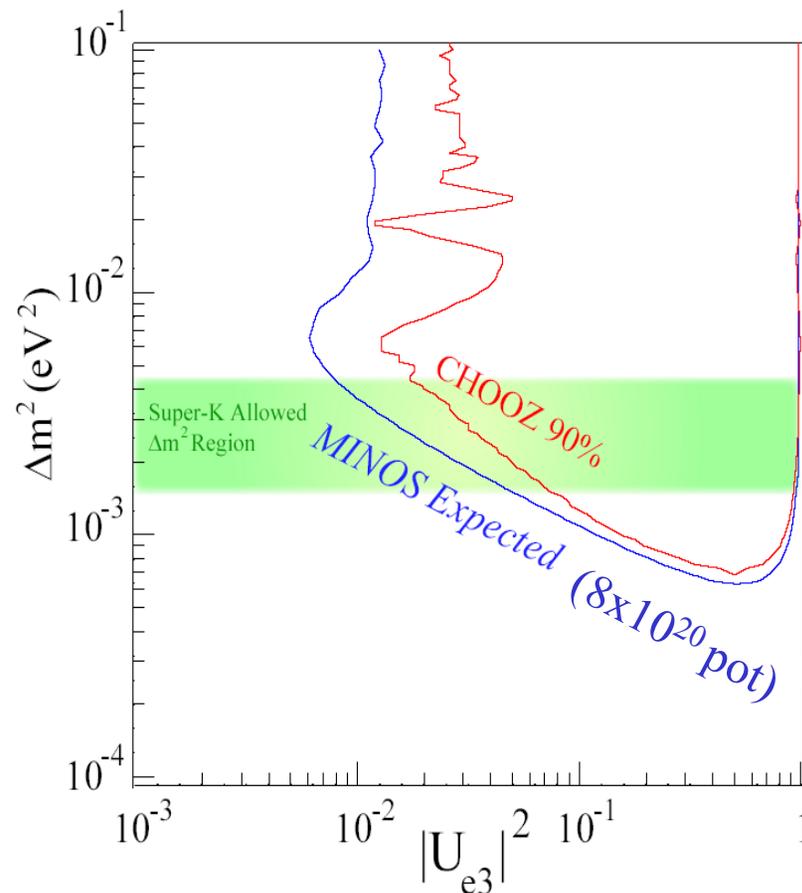
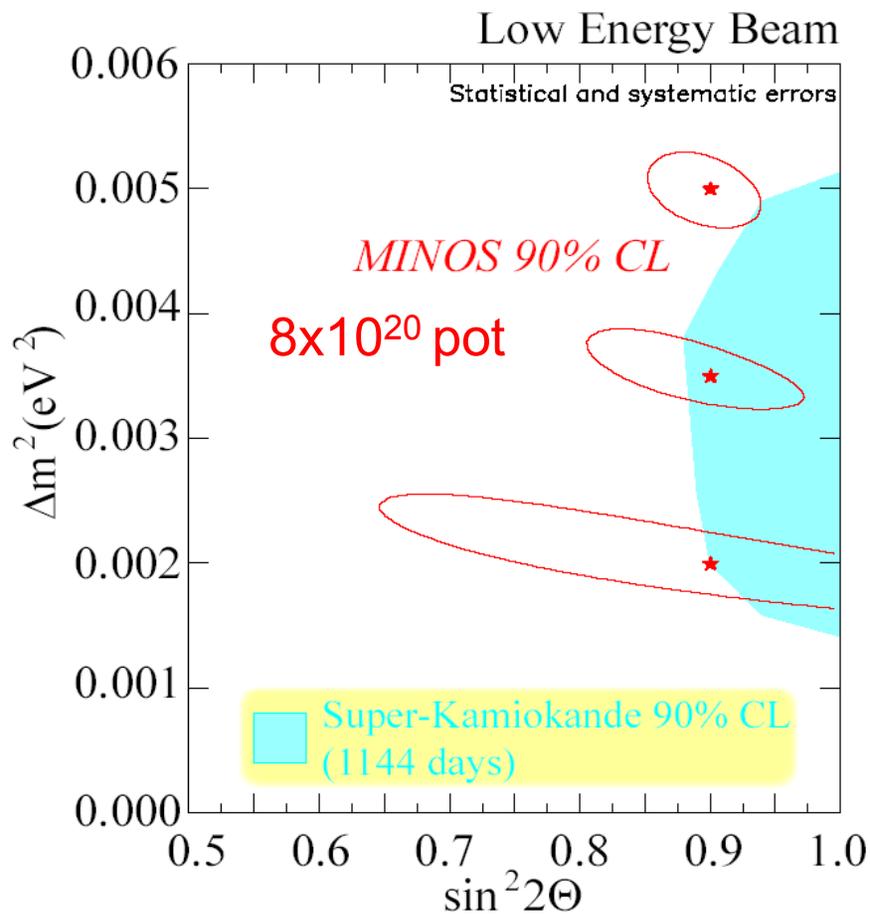
To date: 98976

Largest week: 7192

Latest week: 5459

- Record number of POT is 3x that of 6 months ago.
 - Half of present data sample collected in last two months.
 - New collimator installed this summer will enable the next boost in intensity.

MINOS



- measure Δm^2 and $\sin^2(2\theta)$ precisely

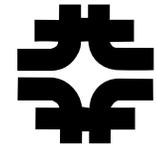
- search for $|U_{e3}|$

Status of the NuMI Project



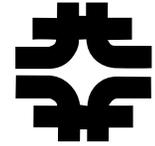
- Good progress on construction
- 482/484 planes of MINOS far detector installed and operating
- After 30 minutes of MI multibatch studies, an intensity record of $\sim 2.5E13$
- Project on schedule for beam commissioning in 12/04
- Just completed a very successful Lehman review

Futures of Neutrino Physics



- Is a new source of CP violation in the neutrino sector accessible to experiments?
 - The 2 neutrino mixing angles measured so far are very large.
 - CP may be observed if θ_{13} , third mixing angle, is not too small.
- Possible steps in an experimental program to explore the neutrino sector
 - **MINOS** measures Δm_{atm}^2 and $\sin^2(2\theta_{\text{atm}})$ well, extends search for θ_{13} .
 - **Off-axis NuMI experiment** offers great discovery potential with modest enhancements of the existing beam. (G. Feldman's Nu Horizons talk)
 - **Proton driver** would greatly increase the neutrino flux.
 - **Very large detector** would further increase sensitivity.

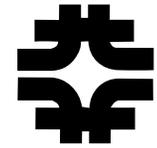
Proton Driver produces intense neutrino beams



HEPAP Facilities plan response:

- “Coupled with a long baseline and a large detector ... the neutrino super beam would permit a comprehensive neutrino science program over a decade or more that would include the precision measurement of neutrino mass differences and oscillation parameters, plus very possibly the measurement of matter-antimatter asymmetries (CP violation) that could connect the neutrino sector to leptogenesis as a source of the baryon asymmetry of the universe.”
- We will soon have the long baseline neutrino beam needed to start this program.

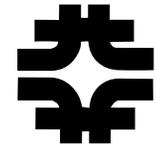
The LHC Program



- US-LHC accelerator
 - Project >80% complete
 - on schedule, on budget
- IR Quadrupoles are well into production.
 - First complete Q2 (2 MQXB magnets) is a great success.
 - Second Q2 is complete.
 - 5 more MQXB complete (half the production)
 - 5 MQXA delivered from KEK.
- Planning the US accelerator research effort with BNL, LBNL



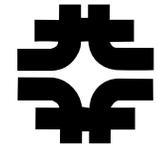
US-CMS



- Project ~80% complete by earned value
 - on schedule and budget baseline
 - very successful Lehman review May, 2002
- Planning the transition to the CMS research program.
 - CMS software and computing project
 - Maintenance and operations
 - strong physics research center for the US participants

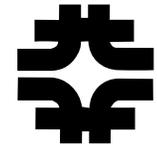


Experimental Astrophysics



- The experimental particle astrophysics effort is well established.
 - First-rate experiments: Auger, CDMS, SloanDSS
 - Important roles suited to Fermilab strengths
 - Modest investment of DOE-Fermilab resources
 - Good ties with the theoretical astrophysics group
- We are starting to plan how this area will evolve.
 - Completion of SDSS is in sight. Group is exploring SNAP as the next project.
 - Auger, CDMS are starting to operate while construction continues.
 - We are looking at how to make the astrophysics effort more coherent and integrated into the laboratory.
- You will hear about all of these experiments tomorrow.

Planning the Future

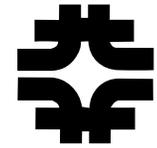


The goals of our planning efforts are

- for U.S. HEP to remain at the forefront of research in particle physics
- for Fermilab to remain the leader in the national effort in particle physics.

- We organize our planning in the context of the planning process for US HEP.
 - HEPAP and its subpanels
 - Facilities plan
 - P5
 - Neutrino task force

HEP facilities plan as submitted



The Weak Scale and the Energy Frontier

- LHC luminosity (and energy) upgrades
- Linear collider R&D

Quark Flavor Physics and CP violation

- BTeV
- CKM
- Super B-factory

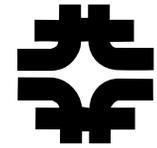
Neutrino and Lepton Flavor Physics

- Off-axis neutrino detector
- Neutrino superbeam
- Neutrino factory
- Double β decay
- (Underground detector)

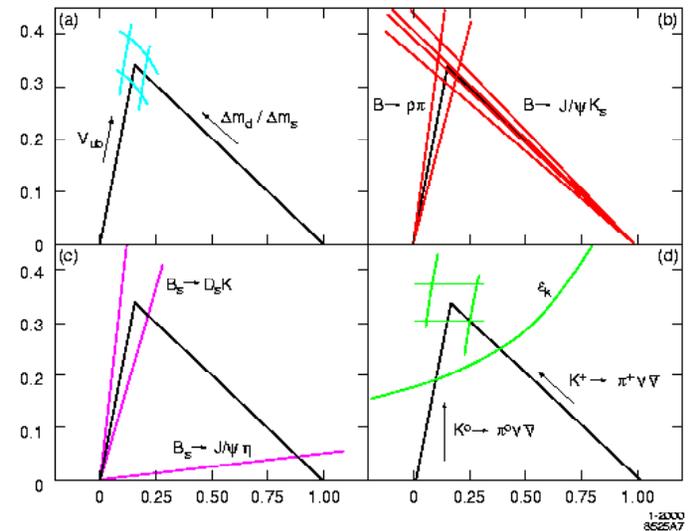
Particle Astrophysics and Cosmology

- SNAP

P5 BTeV and CKM Summary

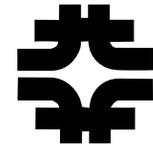


- The goal of the quark flavor physics program is to look for new physics that would show up as an inconsistency between different quark-level diagrams.
- BTeV will be the ideal B experiment in the LHC era.
 - the most precise measurements of critical parameters using B_s and B_d decays
- CKM will be the ideal K experiment in the LHC era.
 - the most precise measurement of V_{td} in K decays
- You will hear about these experiments tomorrow.



- BTeV, CKM, and the Fermilab neutrino program will provide an excellent experimental program at U.S. accelerators.

Fermilab Long-Range Schedule

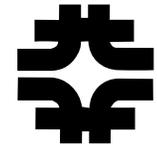


Year		2003	2004	2005	2006	2007
Tevatron Collider		CDF & DZero	CDF & DZero	CDF & DZero	CDF & Dzero	BTeV
						CDF & Dzero
Neutrino Program	B	MiniBoone	MiniBooNE	MiniB	OPEN	OPEN
	MI			MINOS	MINOS	MINOS
Meson 120	MT	Test Beam				
	MC	E907/MIPP	E907/MIPP	E907/MIPP	OPEN	OPEN

Year		2008	2009	2010	2011	2012
Tevatron Collider		BTeV	BTeV	BTeV	BTeV	BTeV
		CDF & DZero	CDF & DZero	OPEN	OPEN	OPEN
Neutrino Program	B	OPEN	OPEN	OPEN	OPEN	OPEN
	MI	MINOS	MINOS	OPEN	OPEN	OPEN
Meson 120	MT	Test Beam	Test Beam	Test Beam	Test Beam	Test Beam
	MC	E906	E906-DrellYan	E906-DrellYan	E906-DrellYan	OPEN
	ME/P	OPEN	CKM	CKM	CKM	CKM OPEN

- RUN or DATA
- STARTUP/COMMISSIONING
- INSTALLATION
- M&D (SHUTDOWN)

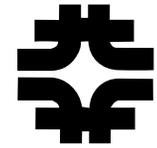
P5 Summary I



I encourage you to say the following in your report:

- **Endorse the evaluation of all these experiments by the Laboratory and the PAC.**
 - State that the standard for approval of these experiments is higher than in the past, because of budget realities.
- Recommend completion of the CDF and D0 detector projects on the appointed schedule.
- Recommend that BTeV be approved for construction on the schedule proposed by the Laboratory, assuming a successful baseline review.
 - State that BTeV will be the best experiment at the end of the decade in the very important area of B physics and will be an excellent part of the world program of particle physics.

P5 Summary II

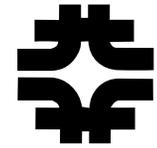


- Recommend that CKM be approved for construction on the earliest schedule that is compatible with funding availability, as worked out by the Laboratory and DOE-HEP.
 - State that CKM will be the best experiment at the end of the decade in the very important area of K physics and will be an excellent part of the world program of particle physics.

In conclusion, state that:

- This plan optimizes the scientific output of US HEP.
- The experiments make excellent use of the existing accelerator complex.
- These evaluations and recommendations are made in the context of the world program and with knowledge of the experiments that might compete for this physics in the future.

The Fermilab program 2010



Physics at the TeV Energy Scale

- US-LHC and US-CMS, with upgrades
- Linear collider getting ready for or starting construction, but where?

Neutrino and Lepton Flavor Physics

- A strong neutrino program based on the upgraded NuMI beam

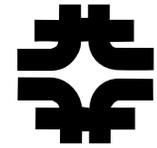
Quark Flavor Physics and CP violation

- BTeV B Physics with the Tevatron
- CKM K Physics with the Main Injector

Particle Astrophysics and Cosmology

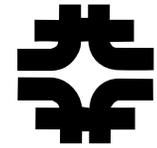
- The Auger Cosmic Ray Observatory, North and South
- The Cryogenic Dark Matter Search, upgraded
- collaboration in SNAP?

Linear Collider



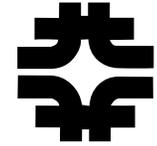
- The upper levels of government are finally reacting to the Subpanel recommendation on developing an international linear collider.
 - Office of Science facilities plan
 - Steps to initiate government-government discussions
 - Discussion of increasing R&D after 3 years of flat funding
 - First funding to universities for accelerator and detector R&D
- The US and International Linear Collider Steering Committees have been working to
 - organize the linear collider as a global project;
 - prepare for a technology decision process;
 - establish a worldwide R&D effort.

Linear Collider



- We proposed in 2001 to the U.S. and to the international HEP community that we work together to build a linear collider at or near the Fermilab site.
 - There is a consensus in the HEP community that the site should be near an existing laboratory if possible.
- Fermilab is an excellent site for a linear collider.
 - strong base of expert manpower and infrastructure
 - excellent locations nearby
 - none of the problems, including political, associated with a green field site
 - good geology
- We need a big step in funding for R&D here if Fermilab is to participate seriously in this effort.

Linear Collider



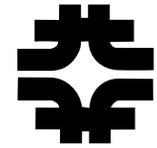
- We are planning to
 - build up the accelerator R&D effort on linear colliders here if given the needed increase in funding for this area;
 - build up a linear collider group that can work with university groups doing R&D on accelerators, detectors and physics.

Fermilab Long-range Planning Committee



- I have convened a long-range planning committee.
 - I have asked them to develop in detail a few realistically achievable options for the Fermilab program in the next decade under each possible outcome for the linear collider.
 - The goal in developing each option should be to optimize the opportunities available at Fermilab in this period for high energy physicists to answer the most important questions in our field.
 - The options should be guided by the priorities for the field as laid out in the HEPAP subpanel and in the HEPAP response to the Office of Science on the facilities plan.
- It is an excellent committee, and is starting to work.

Fermilab Long-range planning committee



Fermilab Staff

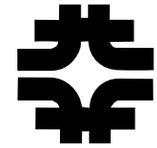
- Hugh Montgomery (Chair)
- Steve Holmes (Deputy)
- Joel Butler
- Marcela Carena
- Josh Frieman
- Steve Geer
- Chris Hill
- Bob Kephart
- Sergei Nagaitsev
- Jim Strait
- John Womersley

External members

- Gary Feldman, Harvard
- Young-Kee Kim, Chicago
- Peter Meyers, Princeton
- Angela Olinto, Chicago
- Ritchie Patterson, Cornell

The Chair will describe their charge and process in his talk tomorrow.

Accelerator Plan



- We submit our Accelerator Plan on June 15.
- Temple review July 1-3
- DOE Lehman review July 21-23
- This as an integrated plan:
 - Operations
 - Reliability improvements
 - Luminosity upgrade
 - Proton economy requirements
- The various components share budget, manpower, and accelerator time.
- We are dealing with this in the environment of a \$17 M shortfall in the FY04 budget request.
 - Accelerator budget \$60 M in FY2001, \$90 M in FY2004, while lab budget below inflation

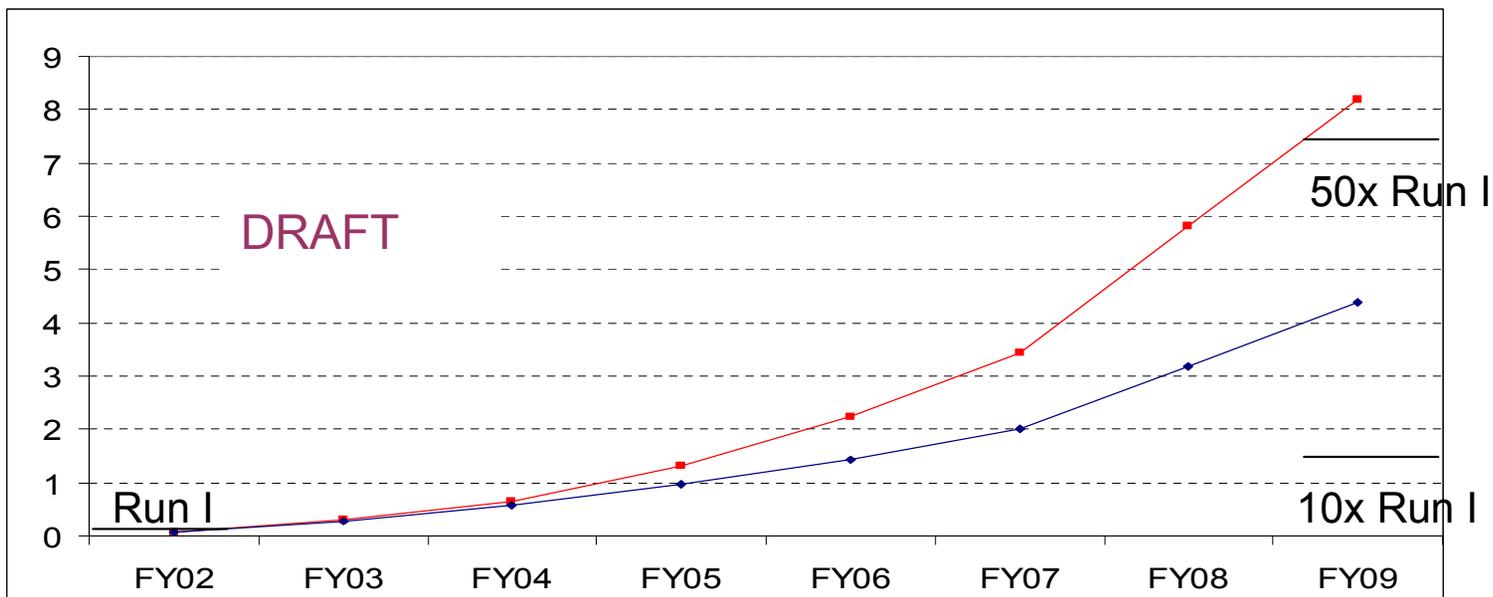
Strategy



The goal is to optimize the science throughout the next several years, given the budget, manpower, and time available.

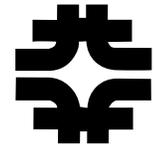
- We will make the large, well-organized effort needed to integrate $\sim 2 \text{ fb}^{-1}$ by Summer, 2006.
 - breakthrough science with $>10x$ the Run I sample
 - Plan includes completion of spillover from FY03 plan, BPM and alignment task forces, plan to address reliability and vulnerability, increased apertures, dampers, lattice match, helix, slip-stacking...
- To get increases beyond this we need
 - aggressive commissioning of the Recycler, balancing need to minimize impact on integrated luminosity
 - installation of electron cooling into the Recycler
 - stacktail upgrade, rapid transfers
- We will carry out a program of steps to improve reliability and reduce vulnerability to disruptive unscheduled shutdowns.

Luminosity projections



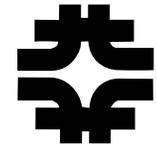
- Luminosity profiles represent possible outcomes of a single, aggressive work plan with another increase in spending.
- The integrated luminosity is lower than we had expected before the detailed study of the last nine months.
- We need to follow the plan of work to get this outcome.
- We will review, with the PAC, the effect of this on the detector upgrade projects.

The DOE Review of the Accelerator Plan



- We will present one integrated accelerator plan, with stretch and base luminosity profiles.
 - It must match the FY04 budget request for the Laboratory.
- We will argue that
 - we have the right plan to optimize the integrated luminosity, given the available time and resources, each year 2004-9;
 - we have a very good chance to meet or exceed the base luminosity profile;
 - we have a reasonable chance to meet the “red” luminosity profile
 - we have backup plans adequate to contend with the acknowledged technical uncertainties.

Summary



- Run II
 - 8 months into FY03, 150 pb⁻¹
 - CDF & D0 detectors getting first physics results
 - completing accelerator plan
- MiniBooNE
 - 6.7x10¹⁸ POT/wk, detector working well
- NuMI
 - project still on target for 12/04 beam
- LHC, CMS
 - projects are in excellent shape
- BTeV, CKM
 - waiting for results from P5
- Long-range planning committee has started work.